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FEB 26 2007

Section II. REMARKS

This addresses the position of the examiner set forth in the Advisory Action mailed January 26, 2007 in this application, and provide supplementary remarks in rebuttal of the rejections and showing the patentable distinction of applicants' pending claims 1-8, 11-14, 16-23, 27-31, 37-41, 43, 45-78, 80-93 and 97-112.

35 USC 112, First Paragraph Rejection of Claims 2, 4-8, 11-14, 16-23, 27-31, 37-41, 43 and 45-64

In the January 26, 2007 Advisory Action, the examiner has contended that:

"Though the applicant includes support for making a ruthenium thin film, it is not shown by the specification, including the processing conditions in the specification and the original claims, that the inventors had possession of making a ruthenium metal thin film layer at the time of the invention. The disclosure of a ruthenium layer is broad in scope and claiming possession of a broad genus of materials does not give one possession of all species in that genus, especially absent a specific working example in the disclosure. Therefore, the 35 USC 112 first paragraph rejection of claims 2, 4-8, 11-14, 16-23, 27-31, 37-41, 43 and 45-64 is maintained." (Advisory Action, page 2, lines 8-15)

This contention is in error. The examiner's attention is directed to Example 3 in paragraphs [0060]-[0062] at pages 20 and 21 of the specification of the present application, and particularly to the empirical results set forth in Table 2 in paragraph [0061]. In Table 2, process results are set forth for deposition of ruthenium films, and such table is reproduced below, for ease of reference.

Table 2: Process conditions for deposition of ruthenium nucleation layer

Process number	T/°C	p/Torr	Reactant gases (wt %)	Deposition rate	Density	Phase	resistivity/ $\mu\Omega\text{-cm}$
1	400	0.8	2% O ₂ /4% H ₂	2.7 A/min	41%	metal	∞
2	300	0.8	90 % O ₂	3.0 A/min	29%	oxide	214
3	300	1.0	90 % O ₂	3.0 A/min	50%	metal	138
4	300	0.8	2% O ₂ /4% H ₂	2.5 A/min	29%	metal	∞

It is apparent from the foregoing Table that processes 1, 3 and 4 produced ruthenium metal, as evidenced by the entries "metal" under the heading "Phase" for such processes, and that process 2 produced a ruthenium oxide film, as evidenced by the entry "oxide" under the heading "Phase" for such process.

On such basis alone, applicants' empirical showings evidence making of a ruthenium metal thin film layer. Processes 1, 3 and 4 evidence different resistivity values, consistent with the description in paragraph [0062] noting that process numbers 1 and 4 produced resistivity values too high to measure, indicating failure to coalesce, but that process numbers 2 and 3 "both produced continuous films" (with the process number 2 forming ruthenium oxide, and process number 3 forming ruthenium metal).

Since applicants in such Example 2 describe the temperature, pressure, reactant gases and their concentration, the deposition rate, and density and phase (metal versus oxide), as well as resistivity of the deposited film, it is apparent that the inventors had possession of making a ruthenium metal thin film layer at the time of the invention, contrary to the examiner's contention.

Further, the 35 USC 112 first paragraph rejection has been premised on the examiner's characterization of applicants' specification as being "absent a specific working example in the disclosure" (Advisory Action, page 2, lines 13-14), whereas in fact Example 2 is a "specific working example."

It therefore is seen that the rejection under 35 USC 112 first paragraph is without tenable basis, and is in disregard of applicants' express disclosure. It therefore is requested that such rejection be withdrawn.

35 USC 102 (b) Rejection of Claims 65-84 and 88-96 Based on Jin et al.

In the January 26, 2007 Advisory Action, the examiner has maintained a rejection of claims 65-84 and 88-96¹ under 35 USC 102(b) over Jin et al., based on the contention that Jin et al. "includes repeating the process in column 4, lines 14-44" (Advisory Action, page 2, line 19).

¹ The examiner in his statement of rejection has ignored the fact that claims 79 and 94-96 were canceled by applicants in their September 29, 2006 Response to the June 29, 2006 Office Action.

This contention is incorrect. For ease of reference, the text of Jin et al. at column 4, lines 14-44 is set out below:

"In one embodiment, the present invention is directed to a method of forming a ruthenium seed layer on a substrate comprising the steps of vaporizing a ruthenium-containing compound; introducing the vaporized ruthenium-containing compound into a CVD apparatus; introducing oxygen into the CVD apparatus; maintaining an oxygen rich environment in a process chamber of the CVD apparatus for the initial formation of a ruthenium oxide seed layer; depositing the ruthenium oxide seed layer onto the substrate by chemical vapor deposition; and annealing the deposited ruthenium oxide seed layer in a gas ambient forming a ruthenium seed layer. Generally, an oxygen to ruthenium ratio from about 1:1 to 100:1 is used. The ratio may also be 14:1. The ruthenium-containing compound is heated to about 200° C. to about 400° C. Examples of these compounds are ruthenium bis-(ethylcyclopentadienyl) and ruthenium octanedionate. The vapor deposited ruthenium seed layer is annealed in an H₂/N₂, H₂ or H₂/Ar gas environment at about 200° C. to about 600° C. Hydrogen gas may comprise about 10% to 100% of the ambient. Representative examples of the substrate include silicon, silicon dioxide, titanium nitride, titanium aluminum nitride, tantalum nitride, tantalum pentoxide and barium strontium titanate. One object of this embodiment is to provide a ruthenium seed layer with a structure of RuO_x prior to annealing of the seed layer, where x is 2, and RuO_x contains about 60% oxygen and after annealing of the seed layer, a ruthenium seed layer with a structure RuO_y is formed, where y is less than 2, and contains less than about 20% oxygen. A ruthenium seed film deposited in accordance with this method may have a thickness of about 100 Å or less." (Jin et al., column 4, lines 14-44)

The requirement for a proper rejection of a claim under 35 U.S.C. §102(b) is set out in MPEP §2131 ("Anticipation - Application of 35 U.S.C. 102(a), (b), and (e)") following the quotation of the statute:

"TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM"

– MPEP §2131

The principle of this boldfaced and capitalized heading then is explained in this MPEP section with reference to the applicable case law:

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). ... "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim... *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

(emphasis added; MPEP §2131)

Viewing the disclosure of Jin et al. relied on by the examiner as the basis for his rejection of claims 65-84 and 88-96 under 35 USC 102 (b), in the light of the above-discussed requirement for a proper rejection, it is seen that, contrary to the examiner's contention, there is *no reference of any kind to repeating, duplication, reduplication, reiteration, repetition, or replication of any process, procedure or step*, nor is there any hint or implication of any such repeating, duplication, reduplication, reiteration, repetition, or replication of any process, procedure or step.

Contrariwise, such disclosure relied on by the examiner is devoid of any derivative basis of applicants' claimed process, as set forth in independent claim 65 (from which all other rejected claims 65-84 and 88-93 directly or indirectly depend):

65. A method for depositing a ruthenium thin film onto a substrate, said method comprising:

(a) depositing a nucleation layer comprising ruthenium onto the substrate by chemical vapor deposition, wherein the nucleation layer is deposited from a nucleation layer ruthenium precursor/co-reactant gas mixture, the mixture having at least a 30 mole % oxygen content, in an oxidizing environment under nucleation layer CVD conditions;

(b) deoxygenating the so formed nucleation layer in a reducing environment, in the absence of the ruthenium precursor/co-reactant gas mixture; and

(c) sequentially repeating steps (a) and (b) until the ruthenium thin film of desired thickness is deposited onto the substrate.

Since Jin et al. does not disclose and contains no hint or implication of "sequentially repeating" the "depositing" and "deoxygenating" steps required by applicants' claimed invention, the basis

of alleged rejection is fatally flawed and does not meet the criteria of 35 USC 102 (b) and MPEP 2131. The rejection of claims 65-78, 80-84 and 88-93 therefore must be withdrawn, since it does not satisfy the requisites of a proper rejection.

35 USC 103 (a) Rejection of Claims 1-8, 11-14, 16-23, 27-31, 37-41, 43 and 45-64 Based on Wade et al. in view of Shinamoto et al.

In the January 26, 2007 Advisory Action, the examiner has maintained the rejection of claims 1-8, 11-14, 16-23, 27-31, 37-41, 43 and 45-64 based on Wade et al. in view of Shinamoto et al.

The requirements for a proper rejection of claims under 35 USC 103 (a) are set out in MPEP 2143 ("Basic Requirements of a Prima Facie Case of Obviousness"):

"To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)." (MPEP 2143; emphasis added)

Applicants' claim 1, rejected on the combination of Wade et al. in view of Shinamoto et al., recites:

"1. A method for depositing a ruthenium thin film onto a substrate, said method comprising:

(a) depositing a nucleation layer comprising ruthenium metal onto the substrate by chemical vapor deposition, wherein the nucleation layer is deposited using a first ruthenium precursor/co-reactant gas mixture having greater than about 30 mole percent of the co-reactant gas, under nucleation layer CVD conditions including a temperature of from about 250°C to about 340°C and a ruthenium precursor gas flow rate that is sufficient to maintain a surface reaction rate-limited deposition; and

(b) depositing an upper layer comprising ruthenium metal onto the nucleation layer by chemical vapor deposition, wherein the upper layer is deposited using a second ruthenium precursor/co-reactant gas mixture having less than 50 mole percent of the co-reactant gas under upper layer CVD conditions, including a ruthenium precursor gas flow rate that is less than that needed to maintain a surface reaction rate-limited deposition."

Wade et al. has been cited as disclosing use of CVD to create a ruthenium seed layer (the examiner citing the title of such reference, "Chemical Vapor Deposition of Ruthenium Films for Metal Electrode Applications"), as well as forming a ruthenium film by CVD (the examiner citing column 4, line 59 to column 5, line 13 of Wade et al.) and depositing a ruthenium oxide seed layer (the examiner citing column 5, lines 14-37 of Wade et al.). The examiner has also alleged that the "examples and tables of Wade anticipate the process conditions given in the claims" (Advisory Action, page 3, lines 9-10).

Shinamoto et al. has been cited:

"to modify Wade to use a ruthenium metal layer as a seed layer. The motivation is to control the oxygen content of the film as was stated in the previous office action (column 4 lines 3-14 and columns 5 and 6 lines 66-17 [sic] of Shinamoto."

This hypothesized "motivation... to control the oxygen content of the film" is, however, a motivation that finds no derivative or supportive basis in either of the Wade et al. or Shinamoto et al. references, and begs the question why, *a priori*, one would be thus motivated, since Wade et al. contain no statement, disclosure, or any description that in any way suggests that the ruthenium films disclosed in Wade et al. are in any way uncontrolled or in any way deficient or unsuitable in respect of oxygen content, such that there would be a need to look elsewhere, e.g., in Shinamoto et al., to resolve such "uncontrolled oxygen content" problem.

Contrarily, Wade et al. assert the effectiveness and suitability of the films and processes they disclose.

For example, Wade et al. disclose at column 2, lines 13-18 that:

"The prior art is deficient in the lack of effective means of depositing pure thin ruthenium films on a substrate using a chemical vapor deposition source that is liquid at room temperature and where deposition temperature occurs in the kinetic-limited temperature range. The present invention fulfills this long-standing need and desire in the art." (Wade et al., column 2, lines 13-18)

The clear import of such statements is that Wade et al. are effective in depositing pure ruthenium films on a substrate, in a manner fulfilling "long-standing need and desire in the art." There is accordingly no basis for attributing to Wade et al. any defect, deficiency or inadequacy in respect of controlling oxygen content in the film that is deposited in accordance with the disclosed process of such reference.

Shinamoto et al. disclose a process that "efficiently forms a ruthenium film with good conformality" (Shinamoto et al., Abstract, line 9), and such reference does not contain any disclosure that would suggest that Wade et al.'s disclosed process produces a film with an "uncontrolled oxygen content" problem that would require fixing by somehow extracting specific process features from the Shinamoto et al. process and importing same into the Wade et al. process.

The "uncontrolled oxygen content" problem therefore is *simply a construct without any tenable or supporting basis in either the references*, which has been posited as the basis for an allegation of obviousness of applicants' claims. It is clear, however, from the foregoing that no such motivation is present.

Since, as stated in MPEP 2143, a proper *prima facie* case of obviousness under 35 USC 103 (a) requires "some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings," and such suggestion or motivation is absent in the present circumstance, it is apparent that the rejection of claims 1-8, 11-14, 16-23, 27-31, 37 and 41, 43 and 45-64 must now be withdrawn.

Remaining Rejections

The examiner in the January 26, 2007 Advisory Action has stated that:

"The remainder of the applicant's [sic] arguments were drawn to arguments already addressed above. Therefore, all rejections of the previous Office Action are maintained by the examiner."

The foregoing appears to be a statement by the examiner that the above-discussed rejections are dispositive of the further rejections of (i) claims 17-19, 43-46 and 97-112 based on Wade et al. in view of Shinamoto et al., as applied above, and further in view of Aaltonen (the last reference having been cited solely for disclosing use of Ru(thd)₃ as a precursor), and (ii) claims 85-87 based on Jin et al. in view of Aaltonen et al. (again cited solely for disclosing use of Ru(thd)₃ as a precursor).

However, the mere citation of Aaltonen et al. as a disclosure of using Ru(thd)₃ as a precursor does not alter the basic fact that *neither* of (i) the Wade et al. in view of Shinamoto et al. hypothesized combination, or (ii) Jin et al., *provides any derivative basis* for the method of applicants' claimed invention, regardless of the specific ruthenium precursor that might be employed.

Since the Wade et al. in view of Shinamoto et al. combination is fatally deficient in providing any motivational basis for the aggregation of such references, as discussed above in relation to applicants' claims against which such combination has been cited, and since Jin et al. fails to disclose or provide any hint of sequentially repeating depositing and deoxygenating steps as required by applicants' claimed 65, from which claims 85-87 indirectly depend, the further citation of Aaltonen does not cure the deficiencies of the respective citations of references with which Aaltonen has been aggregated.

CONCLUSION

In view of all of the foregoing, the rejections maintained in the January 27, 2007 Advisory Action have been overcome. Under the requirements of the statute and applicable MPEP provisions, all pending claims 1-8, 11-14, 16-23, 27-31, 37-41, 43, 45-78, 80-93 and 97-112 are patentably differentiated over the cited references. The claims comport with the requirements of 35 USC 112 first paragraph and are otherwise in proper form. It therefore is requested that a Notice of Allowance be issued, consistent with the patentable character of such pending claims.

Respectfully submitted,



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